

# Tracer PDFs as touchstones for CCM validation: The N<sub>2</sub>O example



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## Abstract:

In the tropical lower stratosphere probability density functions (PDFs) of N<sub>2</sub>O have a distinct two peak structure evidencing the existence of a surf-zone around a region of upwelling. The separation of the two peaks is more pronounced in the winter season than in the summer season. The morphology of MIPAS and MLS derived N<sub>2</sub>O PDFs in different seasons is used to measure the performance of a selection of CCMVal-2 models. The presentation will address the issue of uncertainties in models and observations, and the use of different metrics to assess the similarities between modelled and observed N<sub>2</sub>O PDFs. Most models show reasonable agreement with observations for some seasons and height regions, but only few models capture the seasonal cycle well. It is hoped that this kind of process oriented validation will help to support further model development to improve existing CCMs.

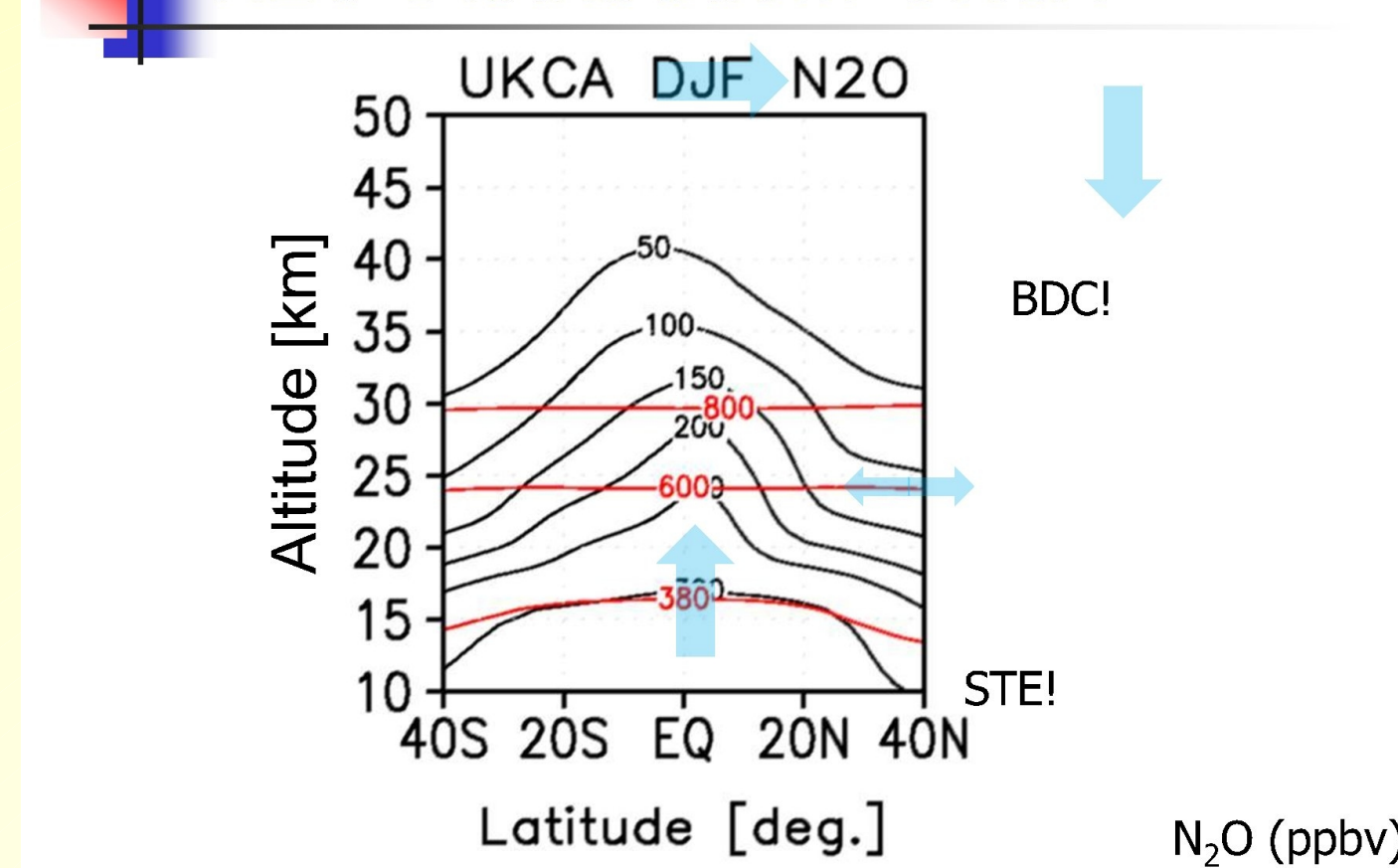
## Model and Data:

Data from the UMUKCA-UCAM Ref1 integration are analysed in this study. The Met Office Unified Model (UM) with 60 levels (L60) extending from the surface to around 83km and N48 horizontal resolution (3.75°x2.5° degrees in longitude and latitude) is used. The chemistry module UKCA is included in its stratospheric setup. The model is integrated along observed monthly-mean sea-surface temperatures and sea-ice coverage from 1960 to 2006.

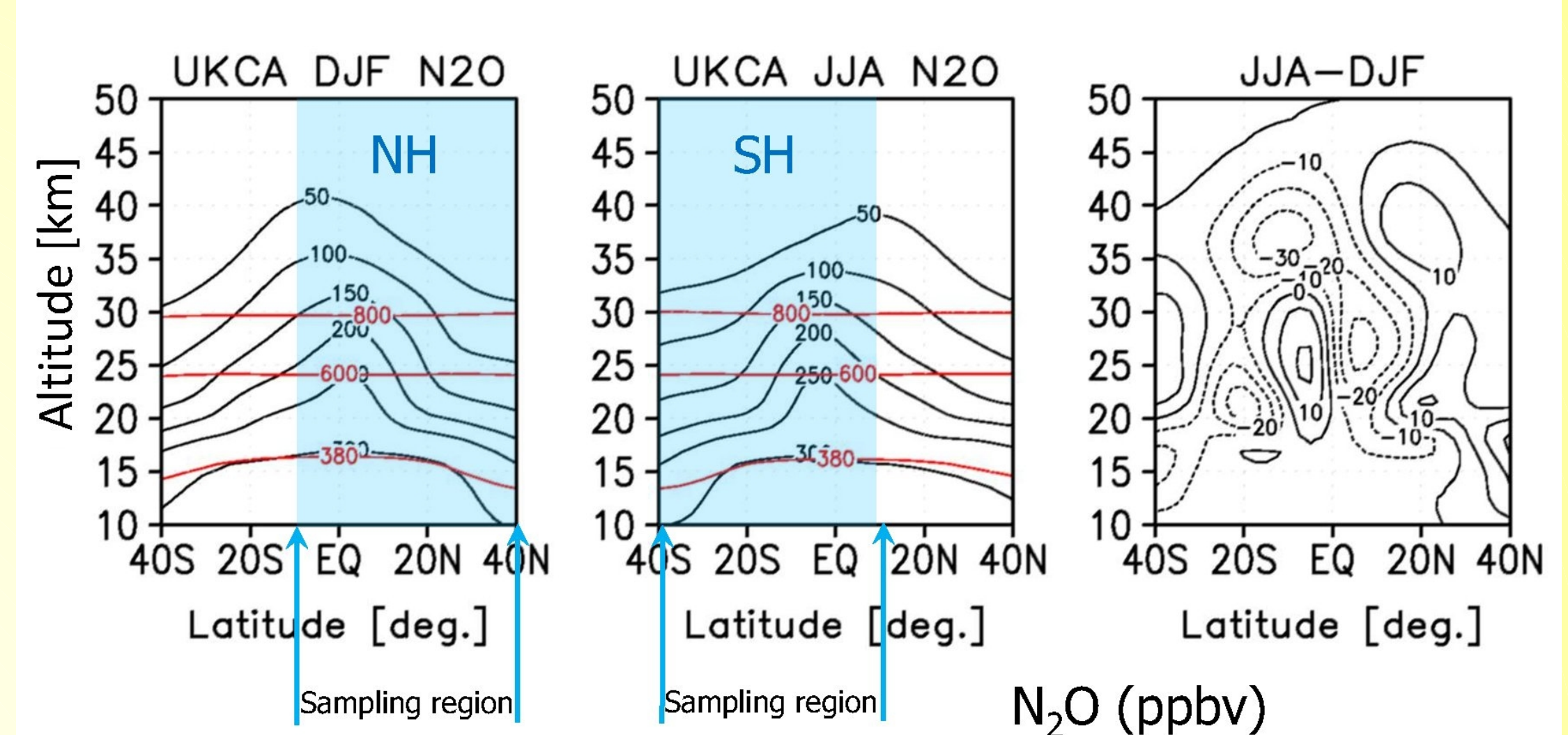
## Introduction

- N<sub>2</sub>O is a transport controlled tracer: The zonal mean reveals already different transport regimes in the stratosphere; PDFs provide a more quantitative picture.
- Uncertainties exist: different observational modes, different instruments ...
- Here: height resolved PDFs for different seasons/hemispheres are evaluated
- Aim: qualitative assessment of models - towards a model grading using N<sub>2</sub>O PDFs.

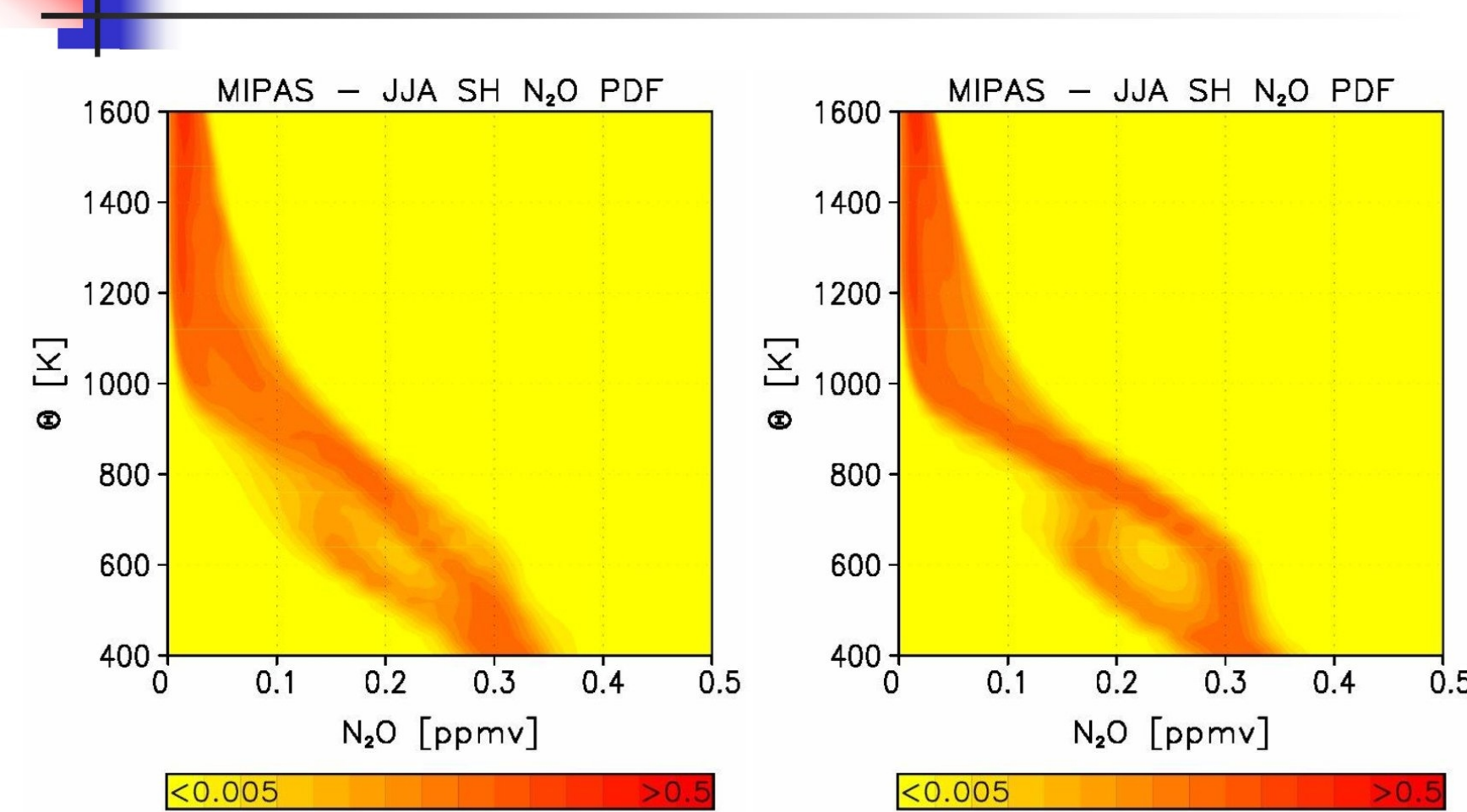
## N<sub>2</sub>O Distribution: UKCA



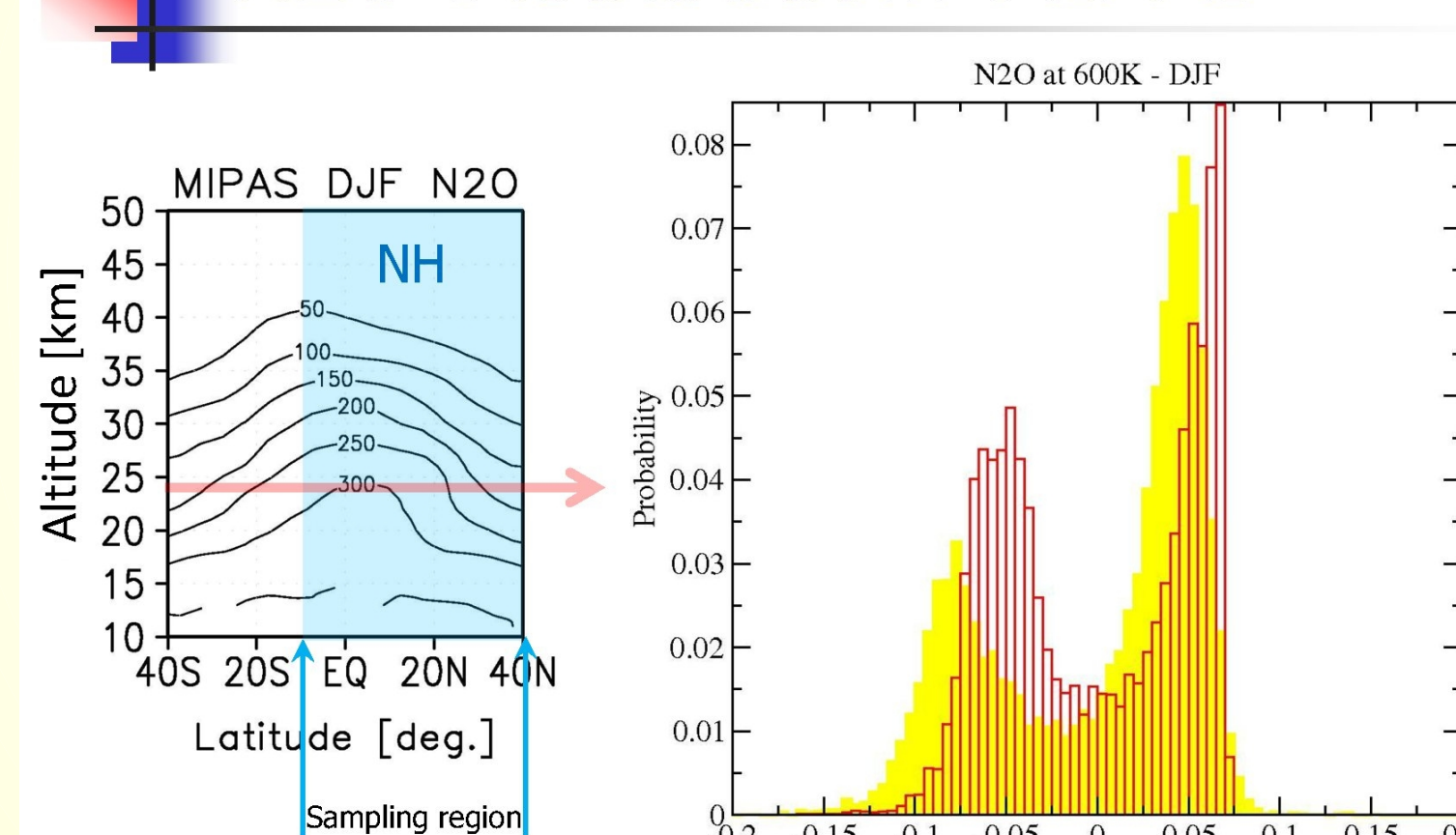
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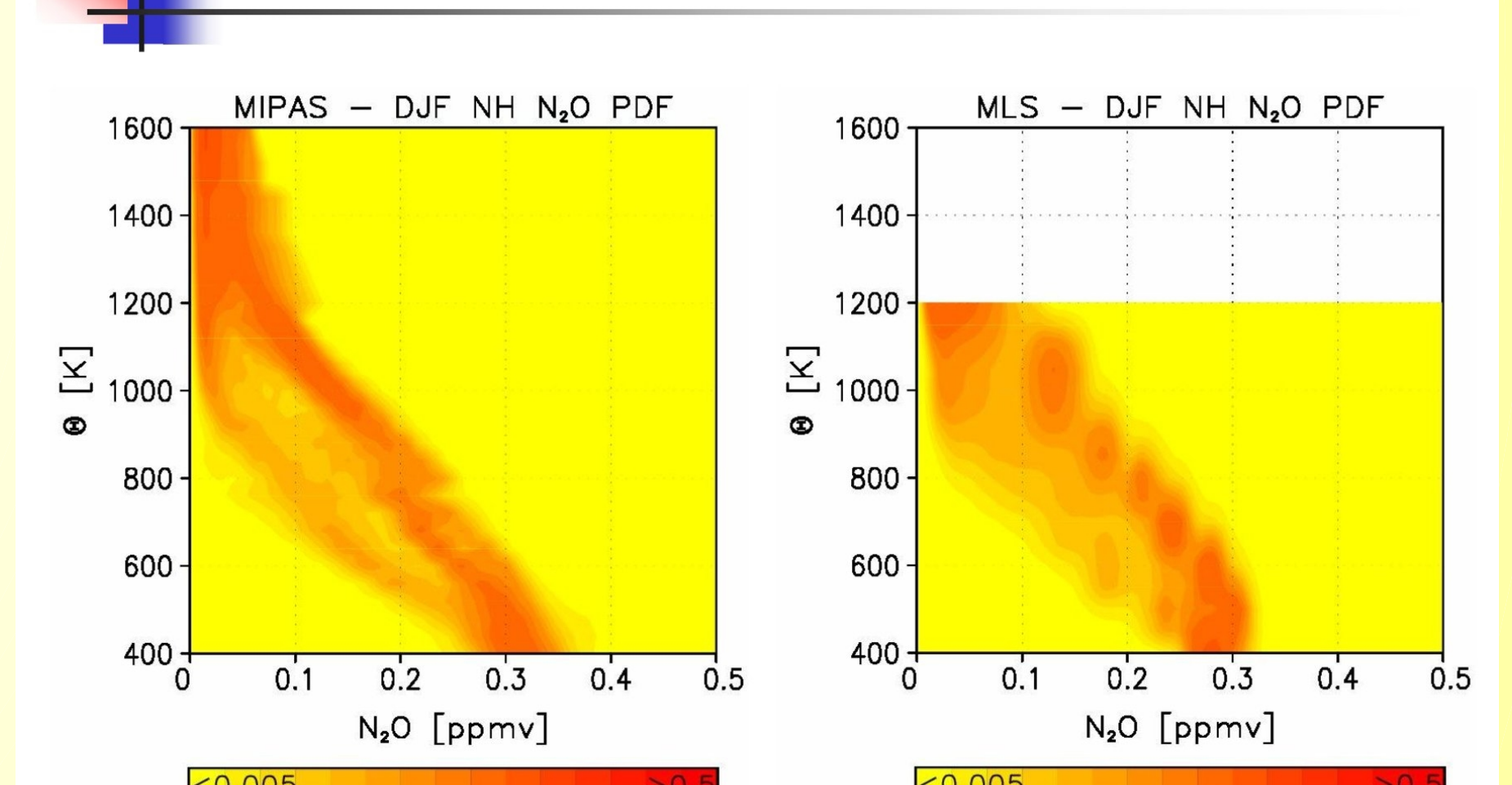
## SH JJA: LowRes versus HiRes



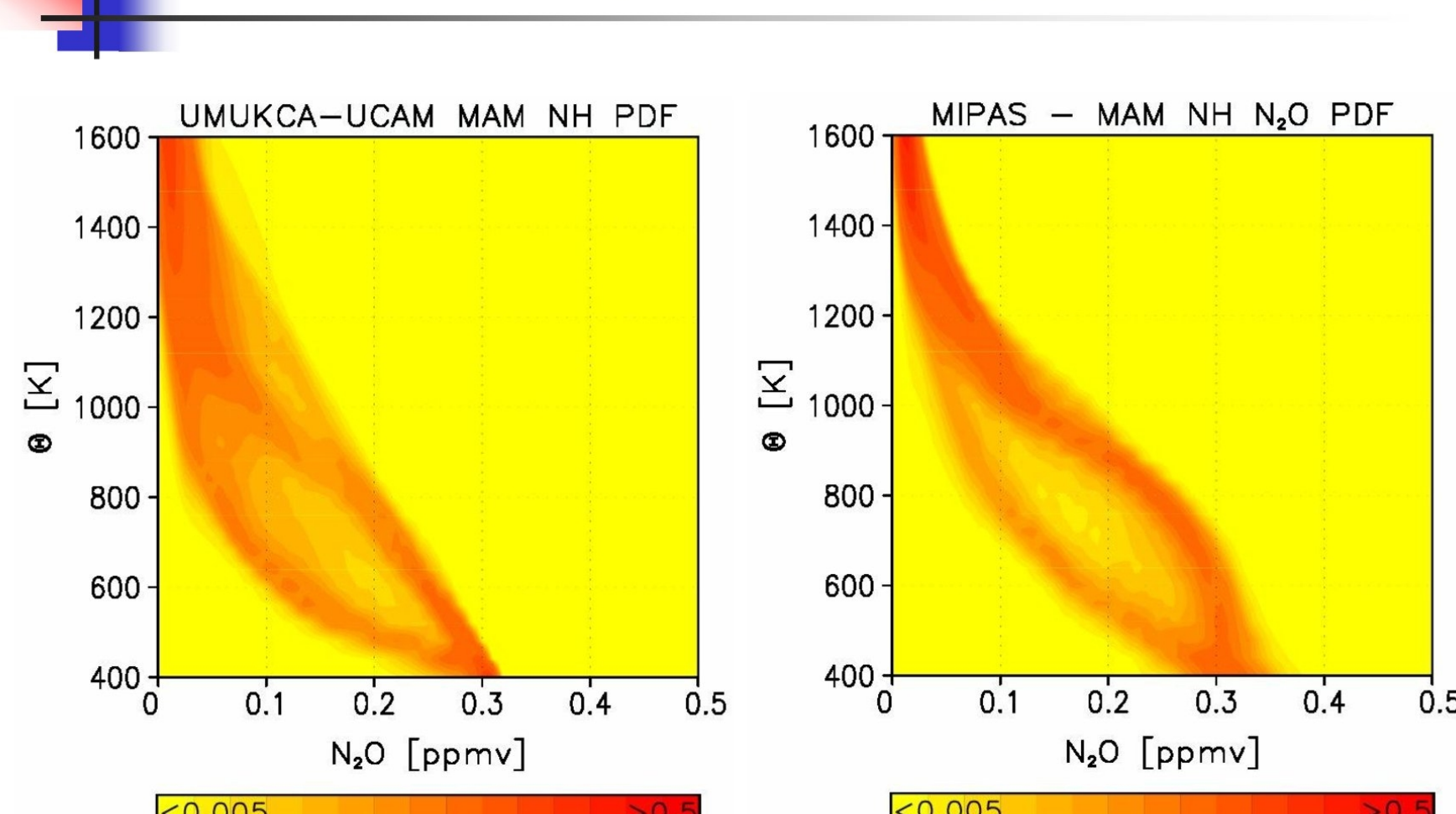
## N<sub>2</sub>O Distribution: MIPAS



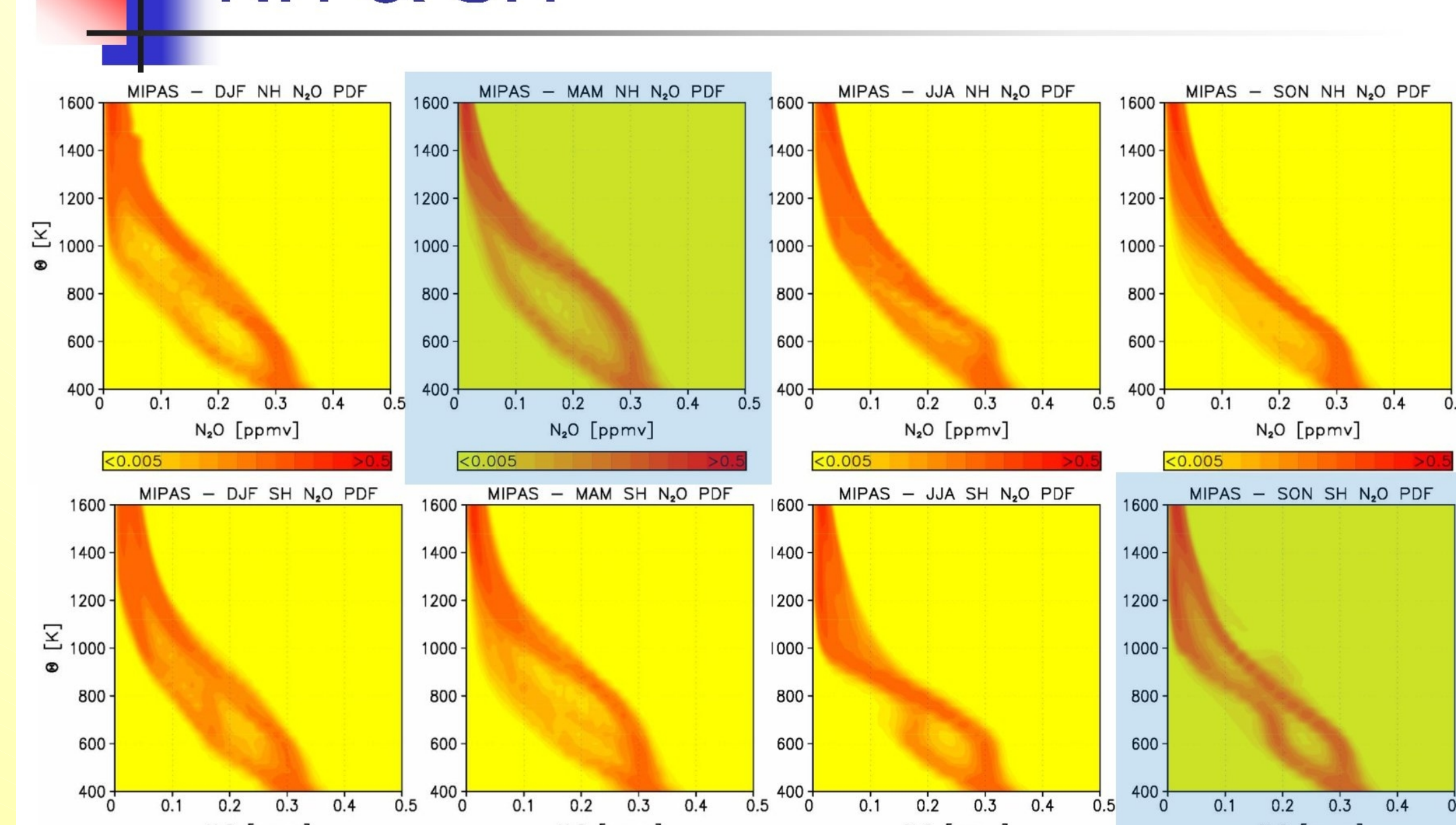
## NH DJF: MIPAS versus MLS



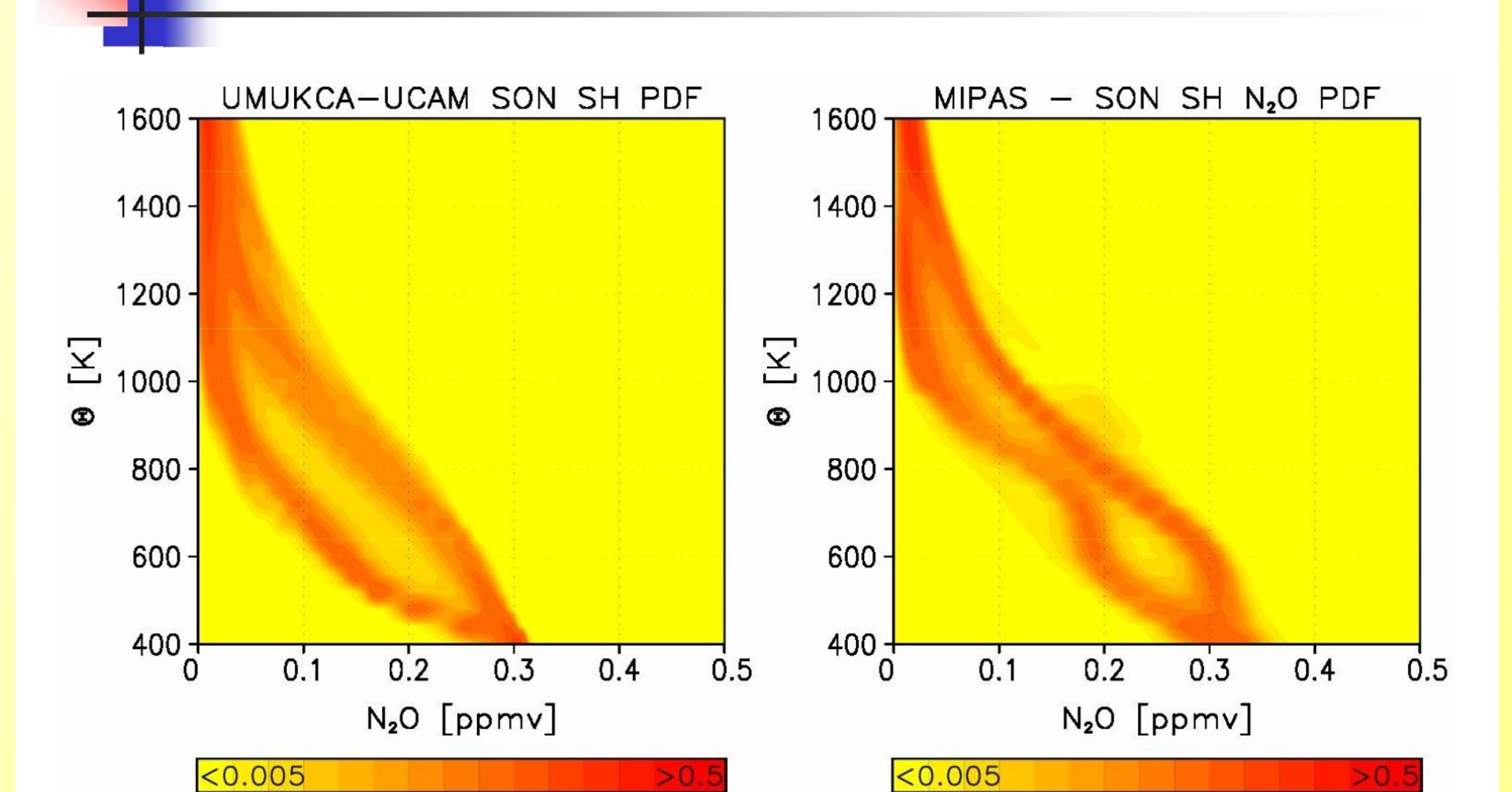
## NH MAM: UKCA versus MIPAS



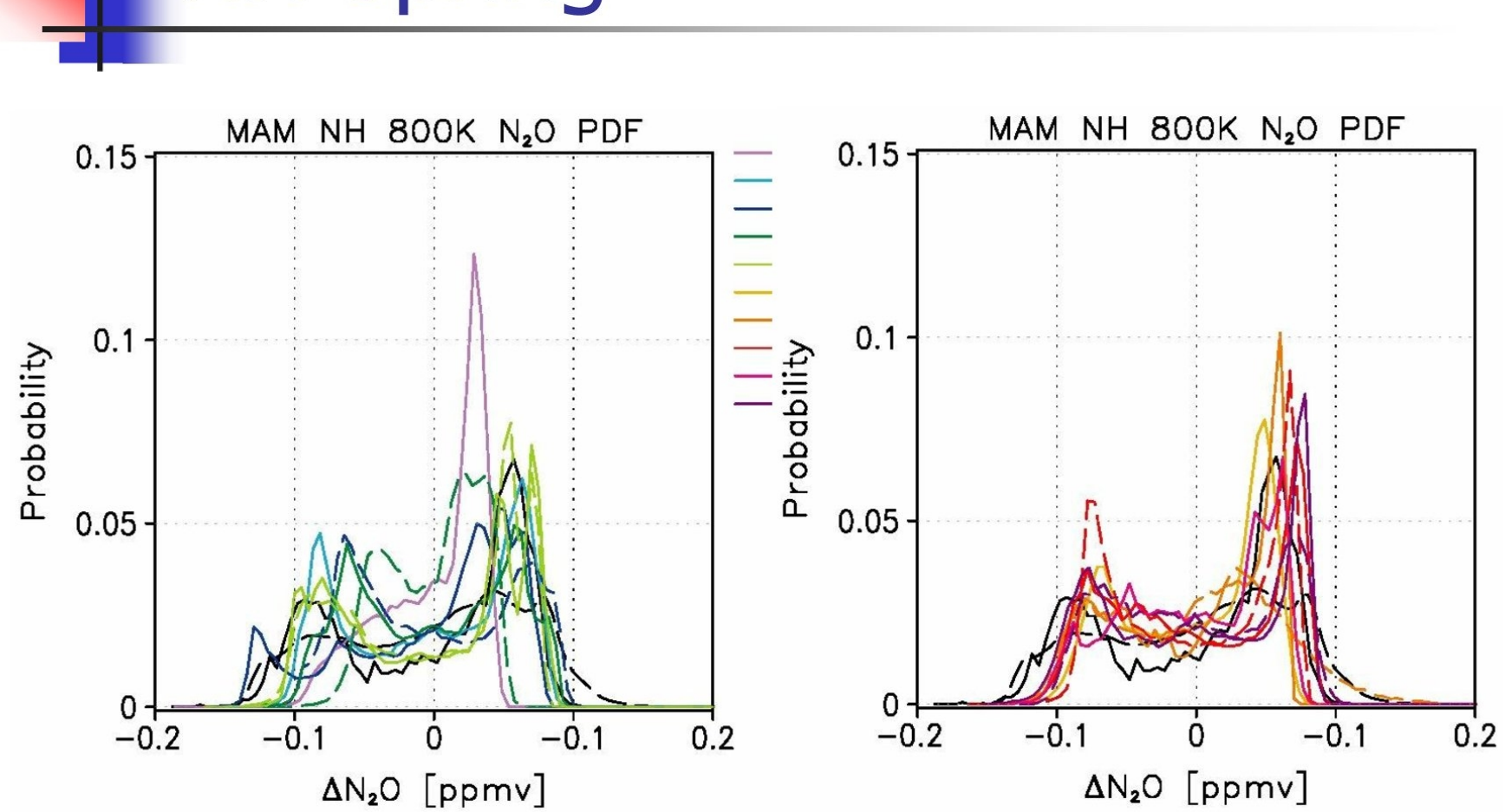
## NH & SH



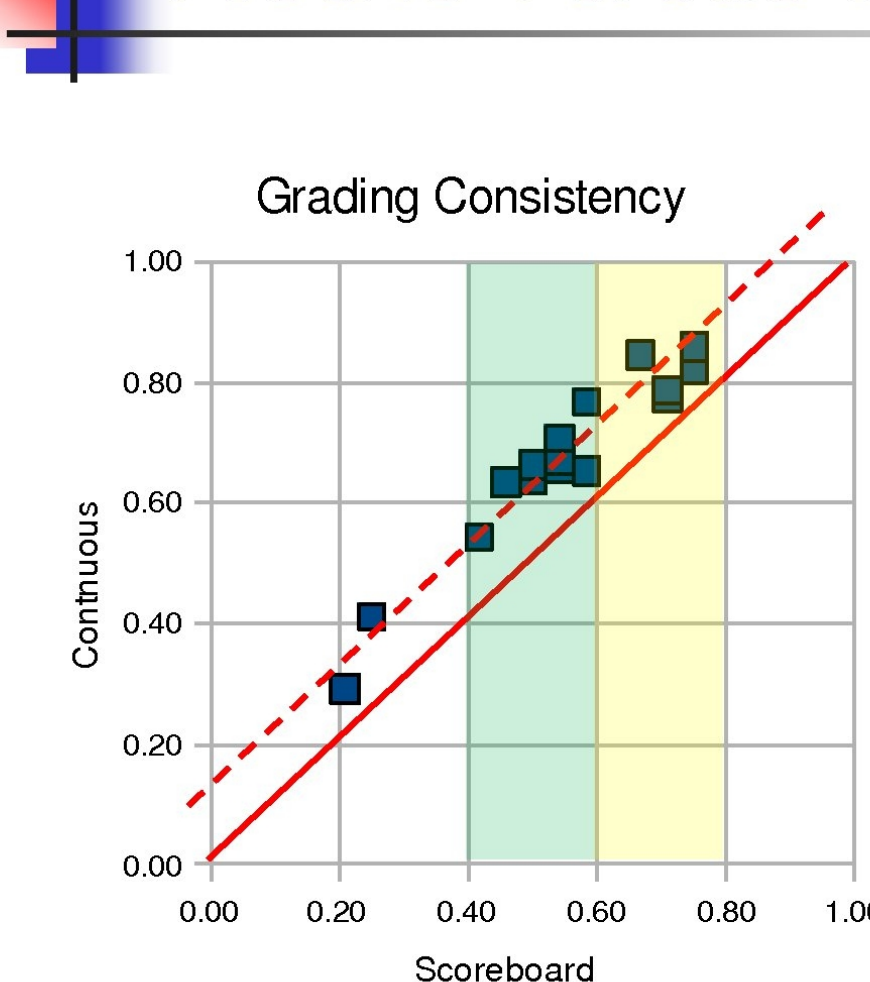
## SH SON: UKCA versus MIPAS



## NH Spring



## Metric versus Metric



Every dot one model!

**Scoreboard:** a point for each category in which abs (model-obs) is below a threshold; the grade is the number of points achieved over all points possible.

**Continuous:** the grade [0;1] is mapped to [0;1].

## Conclusion and Outlook

- MIPAS provides valuable information about low-latitude stratospheric transport regimes.
- Current CCMs (UKCA) are fairly successful in capturing the major characteristics observed.
- Some interesting discrepancies exist (seasonality, depth of surfzone)!
- Models can be graded against observations ...
- ... but our understanding of uncertainties is not perfect!